Review of ORAUT-OTIB-0040, Revision 00 PC-1, "External Coworker Dosimetry Data for the Portsmouth Gaseous Diffusion Plant"

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Subcommittee for Procedure Reviews

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ORAUT-OTIB-0040 – Overview

- NIOSH issued OTIB-0040, rev. 00 PC-1, on November 7, 2006
- Provides information for assigning external dose to Portsmouth Gaseous Diffusion Plant (PGDP) workers who have no or limited monitoring data
- Based on site co-exposure (CE) dosimetry data
- November 16, 2023, the subcommittee tasked SC&A to review OTIB-0040, rev. 00 PC-1
- SC&A issued review of OTIB-0040 on May 29, 2024 (SC&A, 2024)

ORAUT-OTIB-0040 source of data

- NIOSH obtained dosimetry data from:
  - Database “HR_prior_1993.mdb” for monitored PGDP workers
  - Table within database titled “Doseext_dat” containing external data through 1992

NIOSH's analysis of data

- All data corresponded to individual badge readings:
  - Deep dose (penetrating gamma radiation)
  - Shallow dose (penetrating plus non-penetrating (NP) radiation)
- NIOSH analyzed individual badge results to develop CE dose data:
  - Prorated wear time
  - Included missed dose
  - Derived 50th and 95th percentile annual penetrating and shallow doses
  - Derived NP doses
  - Adjusted penetrating dose for construction trade workers (CTWs)

NIOSH prorated wear time

- Prorated recorded annual doses by accounting for average fraction of a given year energy employees (EEs) worked at PGDP. Example:
  - If average time worked for 1965 was 11 months, the derived CE penetrating and shallow doses for 1965 were multiplied by 12/11 = 1.09
- CE doses would then represent a full year of monitored employment
- CE dose would be assigned based on a claimant's specific employment period

NIOSH included missed dose

- Missed dose calculated by multiplying number of null badge readings by dosimeter limit of detection (LOD) and summing results (table 6-1), and:
  - When annual doses were reported as zero – Added one half of the appropriate maximum annual missed doses to the derived annual penetrating and shallow doses
  - If reported positive dose – Maximum missed dose reduced by one badge exchange since it is not possible that all individual badge results were zero
- The above methods would likely change by using the current one person, one sample (OPOS) methodology

NIOSH derived 50th and 95th percentile CE doses

- Derived from adjusted recorded penetrating and shallow doses:
  - Data ranked into cumulative probability curves
  - 50th and 95th percentile doses extracted for each year

NIOSH derived NP dose

- Individual doses recorded in database as penetrating gamma and shallow doses
- NP dose derived by subtracting penetrating from shallow dose
- NP dose to be assigned as >15 kiloelectron volt (keV) electrons, with correction factors applied to account for clothing attenuation or other applicable considerations

NIOSH's recommendations for assigning CE doses

- 50th percentile:
  - Use for best estimate when exposed to intermittent low levels of external radiation
  - Should not be used for workers routinely exposed
- 95th percentile:
  - Use for routinely exposed workers (i.e., workers who were expected to have been monitored)
- External onsite ambient dose should be applied rather than CE dose for workers who were unlikely to have been exposed

Summary of NIOSH's penetrating and NP doses

- Table 8-2 of OTIB-0040 provides a summary of the 50th and 95th percentile annual penetrating and NP CE doses for 1954–1992

NIOSH adjusted penetrating dose for construction trade workers

- Adjustment based on recommendation in ORAUT-OTIB-0052, rev. 00 (ORAUT, 2006b)
- Table 8-3 of OTIB-0040 lists 50th and 95th percentile annual CE penetrating dose for CTWs for 1954–1992

SC&A's review of original PGDP dosimetry data used in OTIB-0040

- Analyzed NIOSH's methods and calculations
- Found NIOSH correctly converted recorded dosimetry data to dose values in table 8-2
- Noted table 8-2 should be labeled as 8-1 (since it is the first table in section 8.0)

Validation of data used for CE dose development

NIOSH

- Compared a sampling of 10 claimants' dosimetry data from NIOSH DCAS Claims Tracking System to data used in the CE dose development for each of the 10 claimants CE
- Covered more than 130 worker-years of monitored employment at PGDP
- Comparison indicated excellent agreement (greater than 99 percent) between the two data sets

SC&A

- Reviewed NIOSH's data validation process and concurs that results indicate data used for CE dose development is valid
- CE data appear to meet criteria set forth in a later document, ORAUT-RPRT-0086, rev. 00 (ORAUT, 2017)

Evaluation of prorated wear time

NIOSH

- Outlines method for prorating recorded doses by accounting for the average fraction of a given year EEs worked at PGDP in section 7.0, item 1, page 8 of OTIB-0040

SC&A

- Concurs with NIOSH's method

Evaluation of adjustment for missed dose

NIOSH

- Outlines method for adjusting for missed dose in section 6.0 and section 7.0, item 2 of OTIB-0040
- Table 6-1 lists penetrating and NP maximum missed dose from 1954–present

SC&A

- Verified data used in table 6–1 is correct according to ORAUT-OTIB-0017, rev. 01 (ORAUT, 2005a) and ORAUT-TKBS-0015-6, rev. 00 (ORAUT, 2005b)
- No findings about NIOSH's adjustment for missed dose but did have one observation

Observation 1: Incorrect reference guidance

- Table 6-1, footnote h:
  - Should read “See ORAUT-OTIB-0017 (Attachment D) for an explanation.” instead of “See ORAUT-OTIB-0017 (Attachment C) for an explanation.”

Evaluation of derivation of 50th and 95th percentile annual penetrating and shallow doses

NIOSH

- Outlines method for deriving 50th and 95th percentile annual penetrating and shallow doses in section 7.0, item 3 of OTIB-0040

SC&A

- Reviewed and concurs with NIOSH's method

Evaluation of derivation of NP doses

NIOSH

- Outlines method for deriving NP annual doses in section 7.0, item 4 of OTIB-0040

SC&A

- Reviewed and concurs with NIOSH's method

Evaluation of NIOSH's recommendations of CE penetrating and NP doses

NIOSH

- Outlines recommendations for use of CE penetrating and NP doses in section 7.0, item 5 of OTIB-0040
- Recommended penetrating and NP CE doses are listed in table 8-2

SC&A

- Reviewed and concurs with NIOSH's method
- However, NIOSH did not provide a reference for a statement in OTIB-0040 concerning radiation effectiveness factors (observation 2)

Observation 2: Reference needed for radiation effectiveness factors

- SC&A requests NIOSH provide a reference concerning the statement at the bottom of page 8 of OTIB-0040:

  *…since the radiation effectiveness factors are the same for >15 keV electrons and >250 keV photons, and are **higher** for 30–250 keV photons.* [Emphasis added.]

- Because OCAS-IG-001, rev. 3 (NIOSH, 2007, p. 58) indicates skin dose conversion factor for 30–250 keV photons is not always greater than for >250 keV for all exposure geometries

Evaluation of adjusting penetrating dose for CTWs

NIOSH

- Outlines method for deriving CE penetrating dose for CTWs in section 8.0 of OTIB-0040
- Recommended penetrating CE doses for CTWs are listed in table 8-3

SC&A

- Reviewed and concurs with NIOSH's method
- Verified table 8-3 dose values are correct
- Noted table 8-3 should be labeled 8-2 since it is the second table in section 8.0

NIOSH's recommendations for assigning neutron dose

- No neutron dosimetry results recorded in PGDP EE files
- Potential for neutron exposure at PGDP in certain areas and facilities
- Recommends ORAUT-TKBS-0015-6 (ORAUT, 2005b) be used for neutron dose assignment when appropriate

SC&A's review of neutron dose

- Reviewed and concurs with NIOSH's evaluation
- ORAUT-TKBS-0015-6 (ORAUT, 2005b) recommends:
  - Neutron-to-photon ratio of 0.2 be applied to photon dose to assign neutron dose for years prior to 1997, if appropriate
- ORAUT-RPRT-0060, rev. 00 (ORAUT, 2019):
  - Provides additional and updated information for PGDP neutron doses
  - Recommends methods to assign neutron dose for PGDP claimants

Evaluation of when to assign ambient dose

NIOSH

- Recommends ambient external dose not be assigned when CE dose is assigned

SC&A

- Concurs with NIOSH's recommendation

SC&A's evaluation of CE penetrating and NP dose values in table 8-2

- Concurs with method NIOSH used
- Performed calculations and reviewed data
- No issues with recommended penetrating and NP CE dose values in table 8-2 of OTIB-0040

SC&A's evaluation of CTW CE dose values in table 8-3

- Concurs with method NIOSH used
- Performed calculations and reviewed data
- No issues with recommended penetrating CTW CE dose values in table 8-3 of OTIB-0040

Conclusions

- SC&A reviewed:
  - The original recorded PGDP dosimetry data
  - NIOSH's use of original recorded PGDP dosimetry data
  - NIOSH's analysis of data and recommendations
  - Data in tables 8-2 and 8-3 of OTIB-0040
- SC&A identified no findings but did have two observations:
  - Observation 1: Incorrect reference guidance in table 6-1 footnote
  - Observation 2: Reference needed for radiation effectiveness factors

Questions ?

References 1

National Institute for Occupational Safety and Health. (2007). *External dose reconstruction implementation guideline* (OCAS-IG-001, rev. 3). https://www.cdc.gov/niosh/ocas/pdfs/dr/oc-ig-001-r3.pdf

Oak Ridge Associated Universities Team. (2005a). *Interpretation of dosimetry data for assignment of shallow dose* (ORAUT-OTIB-0017, rev. 01). https://www.cdc.gov/niosh/ocas/pdfs/tibs/or-t17-r1.pdf

Oak Ridge Associated Universities Team. (2005b). *Technical basis document for Portsmouth Gaseous Diffusion Plant – Occupational external dose* (ORAUT-TKBS-0015-6, rev. 00). https://www.cdc.gov/niosh/ocas/pdfs/arch/portsm6.pdf

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References 2

Oak Ridge Associated Universities Team. (2006b). *Parameters to consider when processing claims for construction trade workers* (ORAUT-OTIB-0052, rev. 00).

Oak Ridge Associated Universities Team. (2017). *Internal dosimetry coworker data completeness test* (ORAUT-RPRT-0086, rev. 00). https://www.cdc.gov/niosh/ocas/pdfs/orau/oraurpts/or-rprt-86-r0-508.pdf

Oak Ridge Associated Universities Team. (2019). *Neutron dose from highly enriched uranium* (ORAUT-RPRT-0060, rev. 00). https://www.cdc.gov/niosh/ocas/pdfs/orau/oraurpts/or-rprt-60-r0-508.pdf

SC&A, Inc. (2024). *A review of ORAUT-OTIB-0040 for external coworker dosimetry data for the Portsmouth Gaseous Diffusion Plant* (SCA-TR-2024-PR040, rev. 0). https://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-tib40-r0-508.pdf